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The Effect of Sand and Time on The Strength of Cement also A Comparative Test of Vulcanite and Dyckerhoff Portland Cements.

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To find the effect of sand and time on cement I proceeded as follows. Eighty briquettes of the cement were made of which twenty were neat cement, twenty, one cement to one sand; twenty, one cement to two sand, and twenty one cement to three sand. Five of each of these sets of twenty were broken after one day in air and one in water, five after one day in air and six in water five after one day in air and twenty seven in water and five after one day in air and fifty five in water. These are called two day, seven day, twenty eight day and fifty six day briquettes respectively.

The comparative tests of the two cements Deyderhoff and Vulcanite

consisted of tensile, setting, warping and checking tests and also tests for fineness of grinding.

The tensile tests were made in the regular course of the tests for the effect of sand and time on the cement that is eighty briquettes of the kinds above named were made from each cement and were broken at the times given.

The setting tests were made on pats of neat cement mixed with twenty per cent of water by means of the Gilmore needles

The checking and warping tests were made on the same pats which were used for the setting tests. After setting, one pat was put under water for fifty six days and one in a moist air box for

the same length of time. These were examined every week and their condition noted.

The sifting tests for fineness were made by sifting a known weight of cement through certain sized sieves and weighing the amount passed.

The briquettes for the tensile tests were made in sets of five. They were made as uniformly as possible, the amount of water for each kind being kept constant in quantity and temperature. The neat briquettes were mixed with twenty per cent of water, one to one with twenty and one half per cent, and one to two, and one to three with ten per cent. The water was in all cases about seventy

degrees Fahrenheit. The moulds for the briquettes were oiled with Cylinder oil before packing the cement in them so that the briquettes could be easily removed. The cement was packed in the moulds by hand entirely. The cement and water, and sand when used were mixed on a glass plate with a small trowel. The briquettes were allowed to remain in the moulds for some time after packing so as to give them time to harden. They were then removed and placed in a moist air box for one day after which they were put in water for the remainder of this time. This water was renewed every week and the pan in which they were kept was washed out. They were broken

in an Olsen Cement Testing Machine of two thousand pounds capacity.

The means of the results obtained from these tests were calculated and from these means two sets of curves for each cement were drawn. One set of curves, number one, shows the increase of strength with time and the other set, number two, shows the decrease of strength as the percentage of sand mixed with the cement increases. The results are given in tables.

Curve one is plotted with the strength in pounds as abscissae and the time in days as ordinates and Curve two has the strength for abscissae and the percentage of sand as ordinates.

In making the setting tests

with the Gilmore needles the time of making the pats was taken. The time when the pat carried a load of one quarter pound on a one twelfth inch needle was taken as the time of initial set and the time when a one pound load on a one twenty fourth inch needle was carried was taken as the time of final set.

The setting times were as follows

	Dyckerhoff.	Vulcanite
Initial	1 hour	45 minutes.
Final	3 hours	2 hours 45 minutes

The pats made for the checking and warping tests showed no defects whatever at any time during the fifty six days they were kept. Both Cements seemed equally good in this respect.

In making the sifting tests

the cements were sieved through sieves numbers fifty, one hundred, and two hundred with the following results.

	Dyckerhoff	Vulcanite
Passed #50	99.5%	99.6%
" #100	43.3%	14.5%
" #200	62.2%	85.6%

The sand used in making the briquettes was of a rather poor quality. It was not coarse enough to give the best results, neither was it very sharp, and a quantity of dirt was mixed with it. When sieved it gave the following results.

Passed #20	45.5%
" #30	78.5%
" #50	21.2%.

From this it may be seen that the tests cannot be comp ared

with tests made with standard quartz and are therefore of no use in determining the general quality of the two cements.

The tables showing the results of the tensile tests are given on pages 12 to 19 inclusive. The curves drawn from these results are on pages 20 to 23 inclusive.

These curves show that the strength of the cement increases very rapidly at first. In nearly every case the strength at seven days is more than two thirds of the strength at fifty six days. After seven days the curve of increase of strength with time is very nearly a straight line and the angle of inclination from the vertical is very slight showing that

the strength increases very slowly after seven days.

By comparing the curves of strength and time for the two cements used we see that the Vulcanite cement has a much higher strength than the Dyckerhoff and also that it reaches its full strength more quickly. The curves for neat cement in each case are probably the best as they pass through all the points and are good smooth curves. They show conclusively the superiority of the samples of Vulcanite over the Dyckerhoff.

The curves of sand and cement show that the strength decreases as the cement decreases or the sand increases. The curves are

very marky straight lines. The strength seems to decrease almost in a direct ratio to the increase of the sand, that is a mixture of one to one is about one half as strong as a neat cement briquette That this is not strictly true is shown by the breaks in the lines that occur in all cases above fifty per cent sand.

In using these curves to compare the two cements we can see more better than from the other set how the Vulcanite cement reaches its full strength more quickly than the Dyckerhoff. The longer time curves are much closer together, than the shorter ones, for the first cement. while for the second cement the curves are more widely spaced.

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The warping and checking tests showed, as I said, that the cements were equally good in that respect.

The setting tests are not very different. the Vulcanite being a little quicker than the Dyckerhoff This is not a matter for comparison however as the time of setting can be controlled by changing the ingredients

The sifting tests are in favor of the Vulcanite, the showing of the Dyckerhoff on the number two hundred sieve being poor.

The whole test shows that the Vulcanite cement is superior to the Dyckerhoff particularly in place where a cement is wanted that will become strong enough to support its load quickly. It should be stated, in justice to the Dyckerhoff cement that the sample used was rather stale.

Table 1 (Dyckerhoff Neat)

Number Briquette	Time days	Strength pounds	Mean
1	56	590	
2	56	599	
3	56	557	
4	56	724	
5	56	668	627.6
6	28	562	
7	28	569	
8	28	541	
9	28	565	
10	28	583	564.0
11	7	498	
12	7	502	
13	7	503	
14	7	447	
15	7	458	481.6
16	2	392	
17	2	376	
18	2	370	
19	2	405	
20	2	355	379.6

Table 2 (Dyckerhoff 1-1)

Number Briquette	Time days	Strength pounds	Mean
1	56	398	
2	56	409	
3	56	420	
4	56	394	
5	56	390	402.2
6	28	344	
7	28	312	
8	28	340	
9	28	387	
10	28	425	361.6
11	7	268	
12	7	255	
13	7	250	
14	7	256	
15	7	303	266.4
16	2	145	
17	2	164	
18	2	168	
19	2	158	
20	2	179	162.8

Table 3 (Dyckerhoff 1-2)

Number Briquette	Time days	Strength pounds	Mean
1	56	290	
2	56	265	
3	56	209	
4	56	227	
5	56	269	252.0
6	28	263	
7	28	238	
8	28	203	
9	28	311	
10	28	321	267.2
11	7	142	
12	7	148	
13	7	158	
14	7	147	
15	7	159	150.8
16	2	59	
17	2	81	
18	2	63	
19	2	50	
20	2	70	64.6

Table 4 (Dyckerhoff 1-3)

Number Briquette	Time days	Strength pounds	Mean.
1	56	230	
2	56	196	
3	56	203	
4	56	224	
5	56	175	205.6
6	28	186	
7	28	141	
8	28	152	
9	28	163	
10	28	180	164.4
11	7	118	
12	7	101	
13	7	111	
14	7	102	
15	7	116	109.6
16	2	30	
17	2	27	
18	2	36	
19	2	22	
20	2	24	27.8

Table 5 (Vulcanite Neat)

Number Briquette	Time days	Strength pounds	Mean
1	56	832	
2	56	840	
3	56	946	
4	56	877	
5	56	957	890.4
6	28	887	
7	28	855	
8	28	858	
9	28	822	
10	28	848	854.0
11	7	830	
12	7	728	
13	7	807	
14	7	786	
15	7	750	780.2
16	2	576	
17	2	573	
18	2	690	
19	2	718	
20	2	482	607.8

Table 6 (Vulcanite 1-1)

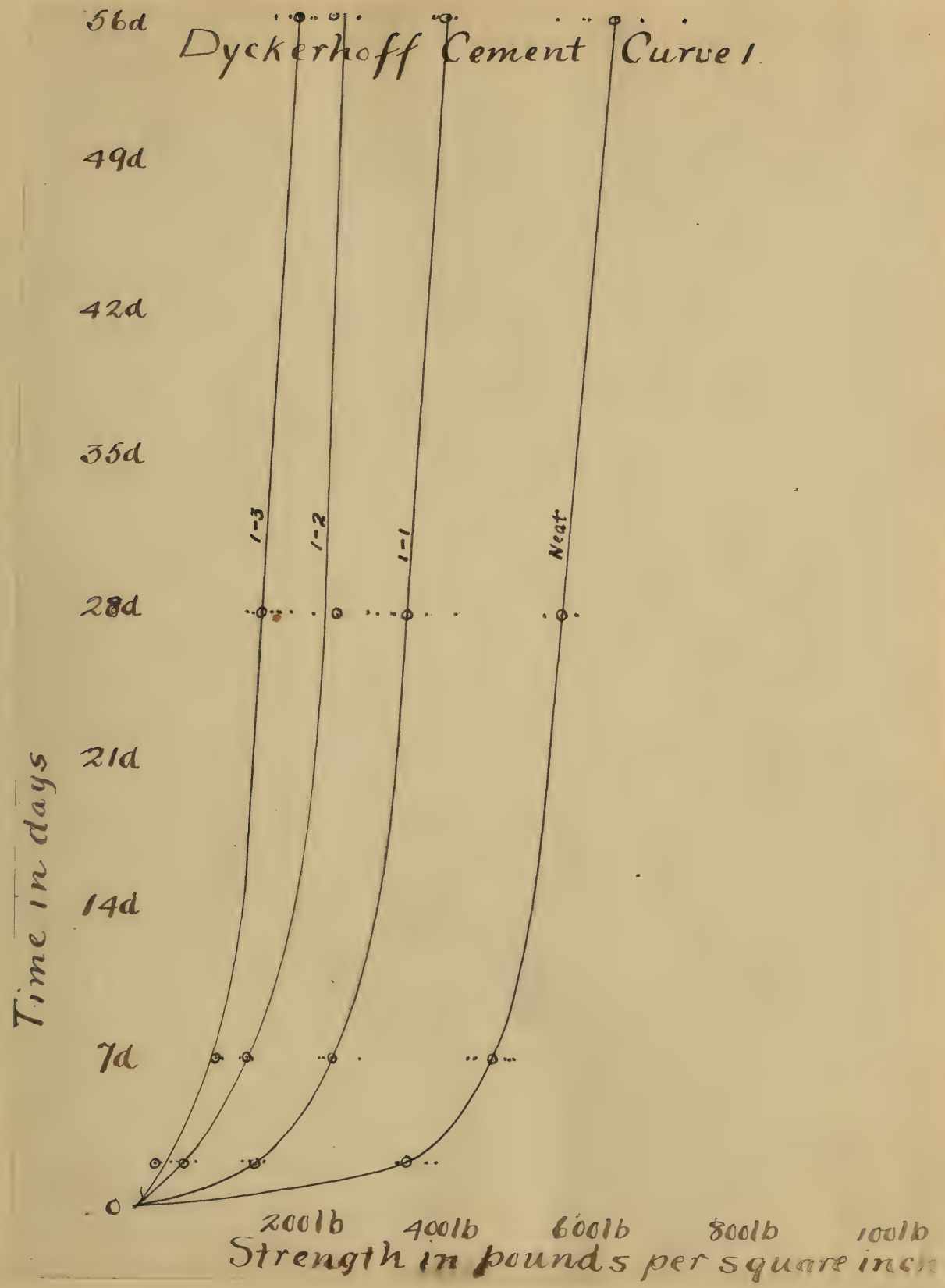
Number Briquette	Time days	Strength pounds	Mean
1	56	482	
2	56	450	
3	56	450	
4	56	467	
5	56	523	474.4
6	28	445	
7	28	454	
8	28	487	
9	28	487	
10	28	447	464.0
11	7	392	
12	7	438	
13	7	428	
14	7	438	
15	7	464	432.0
16	2	303	
17	2	332	
18	2	402	
19	2	352	
20	2	293	336.4

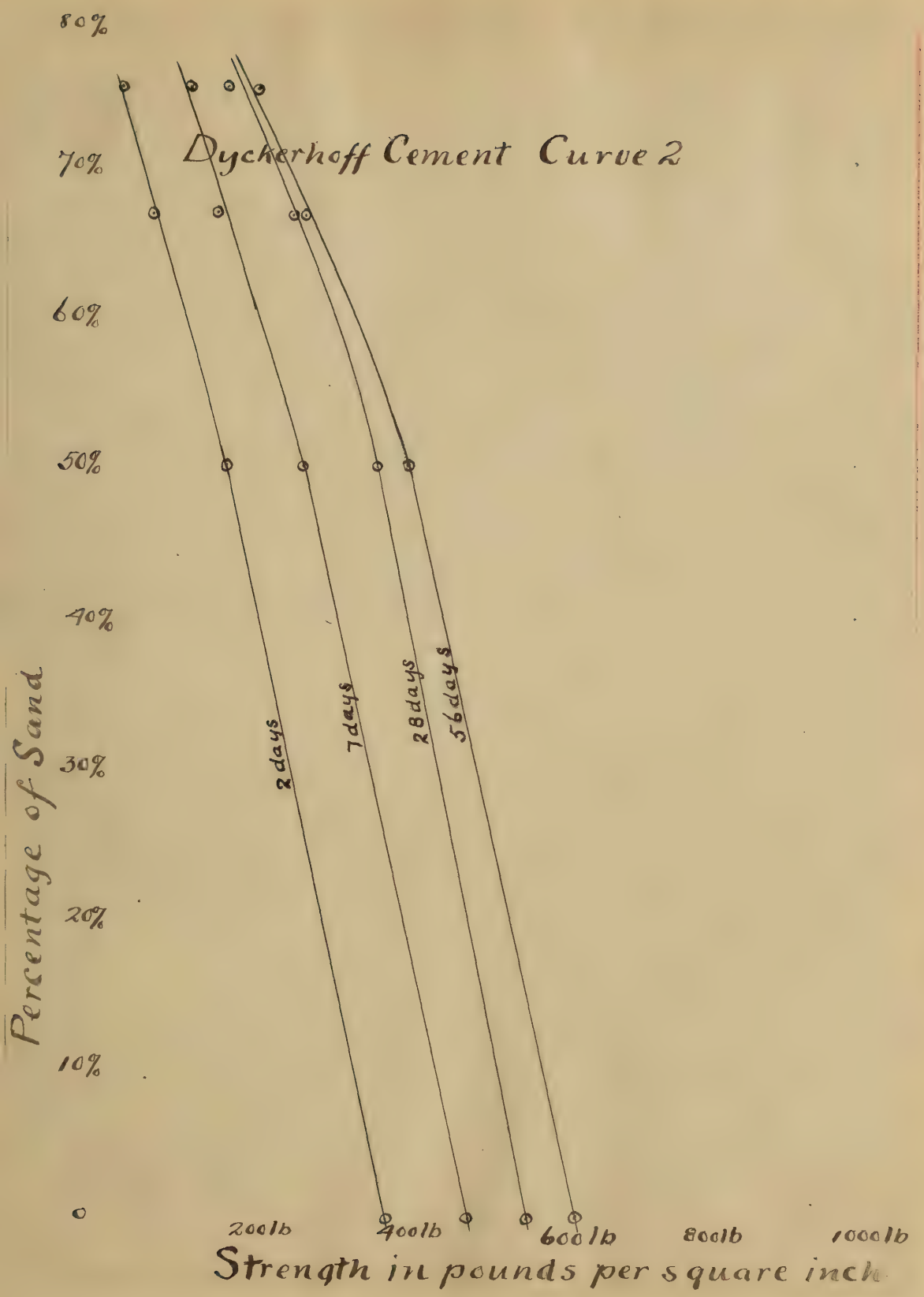
Table 7 (Vulcanite 1-2)

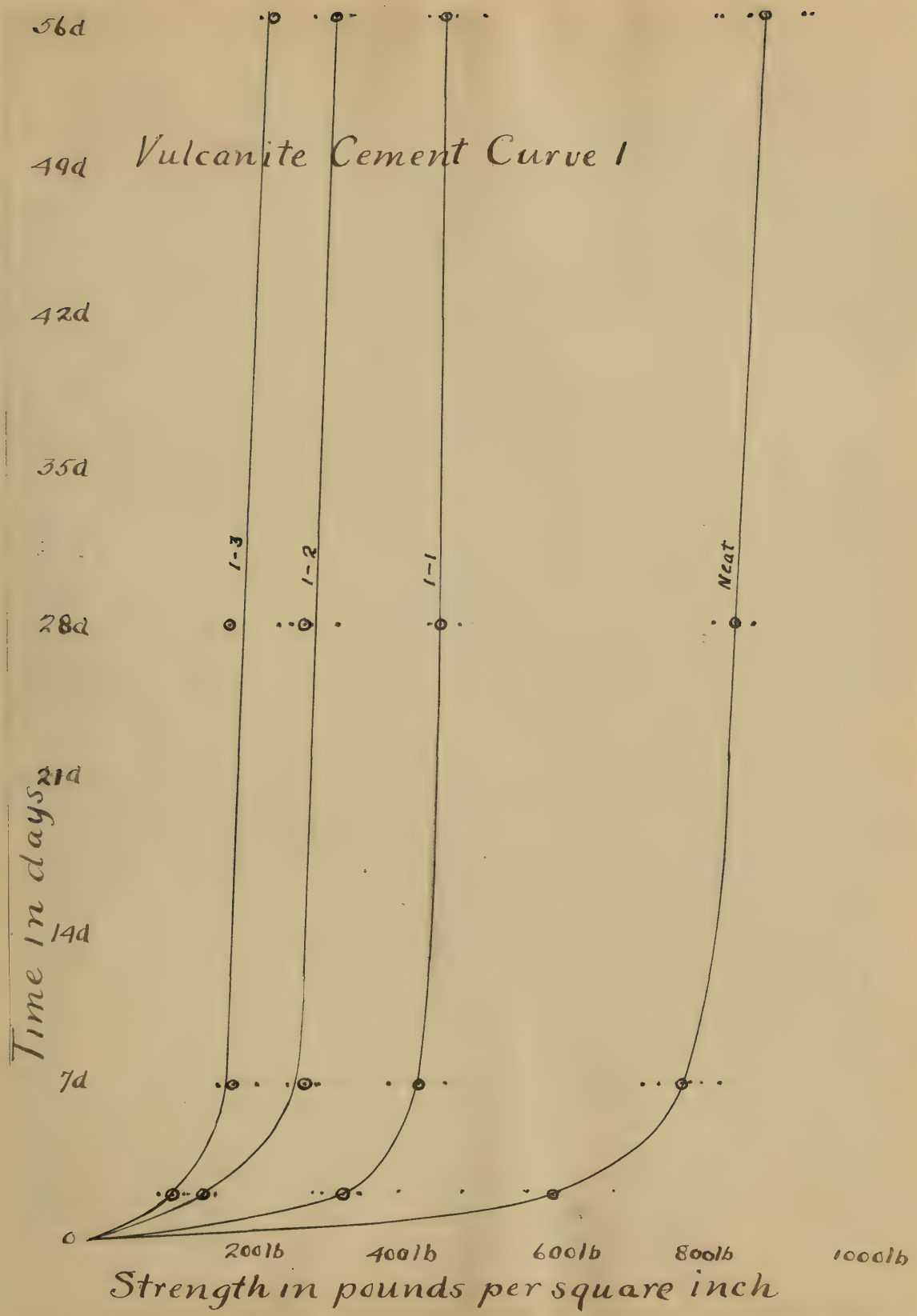
Number Briquette	Time days	Strength pounds	Mean
1	56	300	
2	56	351	
3	56	349	
4	56	326	
5	56	321	342.4
6	28	251	
7	28	290	
8	28	268	
9	28	288	
10	28	327	284.8
11	7	282	
12	7	287	
13	7	302	
14	7	260	
15	7	300	286.2
16	2	143	
17	2	149	
18	2	136	
19	2	165	
20	2	154	149.4

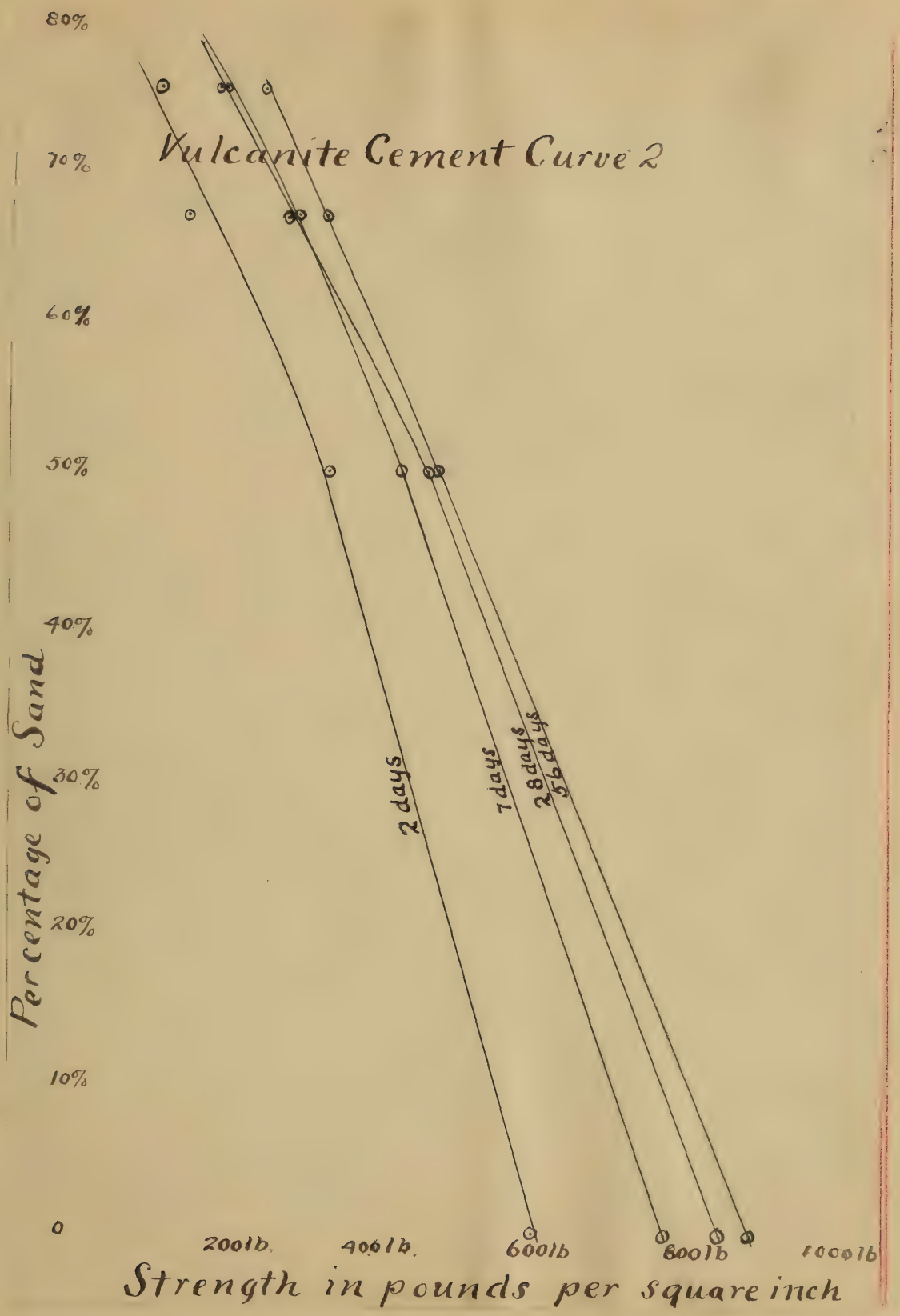
Table 8 (Vulcanite 1-3)

Number Briquette	Time days	Strength pounds	Mean
1	56	241	
2	56	245	
3	56	253	
4	56	231	
5	56	244	242.8
6	28	182	
7	28	182	
8	28	186	
9	28	190	
10	28	142	186.4
11	7	187	
12	7	220	
13.	7	190	
14	7	181	
15	7	168	189.2
16	2	96	
17	2	109	
18	2	97	
19	2	115	
20	2	133	110.0


Dyckerhoff Cement Curve 1
56d
49d
42d
35d
28d
21d
14d
7d
0
1-3
1-2
1-1
Neat
Time in days
200lb
400lb
600lb
800lb
1000lb
Strength in pounds per square inch


Dyckerhoff Cement Curve 2
80%
70%
60%
50%
40%
30%
20%
10%
0
Percentage of Sand
2 days
7 days
28 days
56 days
200lb
400lb
600lb
800lb
1000lb
Strength in pounds per square inch


Vulcanite Cement Curve 1
56d
49d
42d
35d
28d
21d
14d
7d
0
Time in days
1-3
1-2
1-1
Neat
200lb
400lb
600lb
800lb
1000lb
Strength in pounds per square inch


Vulcanite Cement Curve 2
80%
70%
60%
50%
40%
30%
20%
10%
0
Percentage of Sand
2 days
7 days
28 days
56 days
200lb.
400lb.
600lb
800lb
1000lb
Strength in pounds per square inch

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